COMPARATIVE OBSERVATIONS ON THE FLORAL PRIMORDIUM OF SALVIA NEMOROSA L. AND PAPAVER SOMNIFERUM L. WITH REGARD TO THE INITIAL CONDITIONS OF PISTIL ORGANIZATION

by

P. GRACZA

Department of Applied Botany and Histogenetics of the Eötvös Loránd University, Budapest

Received on November 28th, 1969

Examinations of pistil organization carried out in our Institute include a study of pistil types which are regarded as intermediate forms between the development of inferior and superior pistils. A description of the pistil of *Syringa vulgaris* L. has already been published (Gracza, 1968). The present paper deals with the organisation of the floral primordium of *Salvia nemorosa* L. as compared to that of *Papaver somniferum* L. with a view to find out the development of the pistil – generally known as superior – of the two species at the beginning of floral organization in its primordial stage.

Both the morphological and the histological aspect of floral organization were studied in the genus *Salvia* and, in general in the family of *Labiatae* (Van Tieghem, 1867; Schuman, 1904; Solereder, 1908; Carlson – Stuart, 1936; Eames, 1947; Takhtajan, 1948; Sárkány – Szalai, 1966). Floral organization of *Papaver somniferum* L. was described in the last two decades (Bersillon, 1951, 1955; Sárkány – Percs, 1957; Gracza, 1964).

Materials and Methods

Developing inflorescense of *Salvia nemorosa* L. was collected in the Botanical Garden of the Eötvös Loránd University, while floral buds and flowers of *Papaver somniferum* L., belonging to different stages of development, were obtained from the Biological Station, Alsógöd. Flowers in several stages of development were fixed in Bouin's solution and, after repeated washing in 70 per cent alcohol, dehydrated and gradually embedded in paraffine. Microtomic serial sections were stained in Ehrlich's haematoxiline and covered in Canadian balsam. Microphotos were made of the characteristic stages of development.

Discussion

In the case of *Salvia nemorosa* L. the examinations were started on dichasial spike inflorescence with half open flowers on the basal part. The detailed observations include at first the floral primordium stage at the apical region (floral shoot apex) and then, proceding downwards, 4 – 5 stages of development on 5 – 6 nodes.

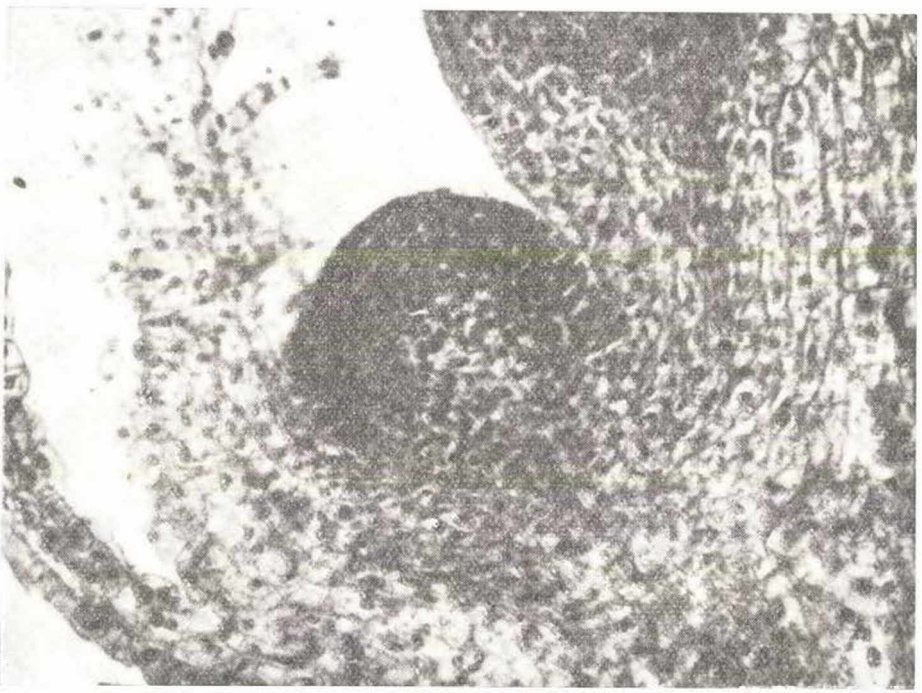

Fig. 1. Reproductive shoot apex of *Salvia nemorosa* L. (400x)

The first to become differentiated on the floral shoot apex are the decussate bract primordia, while a further part of inflorescence primordium is developing in their axils. At the following, lower level the inflorescence primordium is divided into three floral primordia; the following observations refer to the central one, which is in a somewhat more advanced stage of development. Due to the intensive activity of the peripheral meristemes the young hemispherical

reproductive shoot apex covered with three tunica layers (Fig. 1.) increases vigorously on the peripheral parts and soon levels with the central apical part. Consequently the shoot apex gradually gets a flat surface before the floral leaves would begin to initiate. Subsequently cell divisions begin in the third tunica layer with the insertion of periclinal walls, as a result of which there are five sepal initials which begin to develop at the peripheral part of the floral

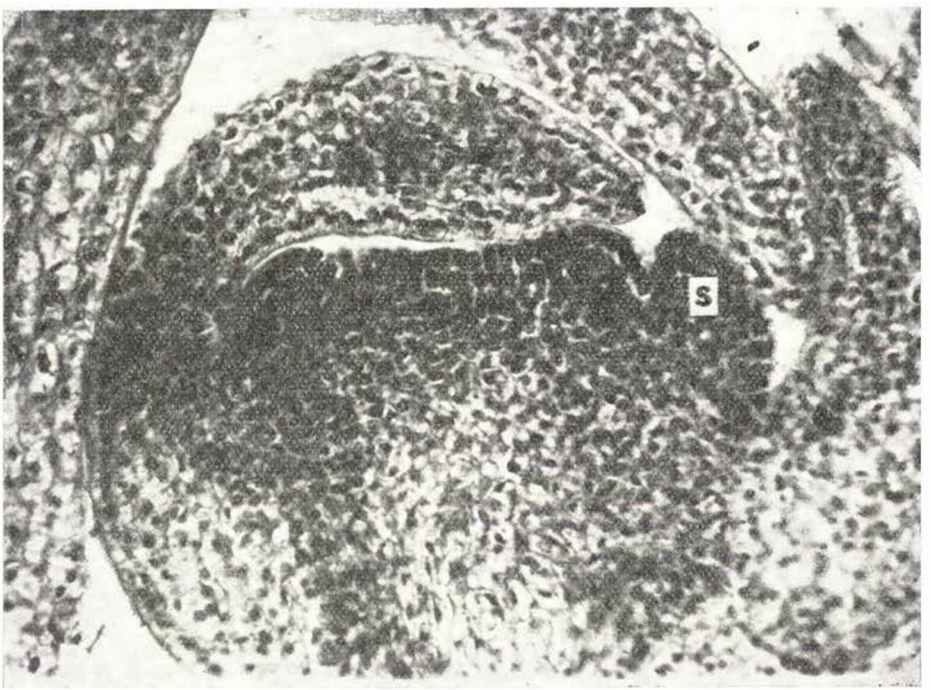

Fig. 2. Floral primordium of *Salvia nemorosa* L. with sepal initials. (400x)

primordium (Fig. 2). Further cell divisions take place centripetally in the third tunica layer, inside the sepal initials, and five petal primordia are initiated in alternate position. Due to the anticlinal and periclinal division and to the elongation of its cells, the reproductive shoot apex continues to grow and widens rather in a horizontal sense than upwards; consequently the anther initials emerge from the flat inner surface of the shoot apex at the same level as the sepal and petal initials, inwards from them. At the beginning of development

the two carpels which develop after the anther primordia are somewhat receded as compared with the other floral leaves (Fig. 3). This feature shows a close resemblance to the receded leaf initials of genuine inferior pistils. It is only at the beginning of initiation that the carpel initials are at a somewhat deeper level as compared with the initial level of other floral leaves, since – due to the activity of the meristematic zone remaining for a rather long time in the

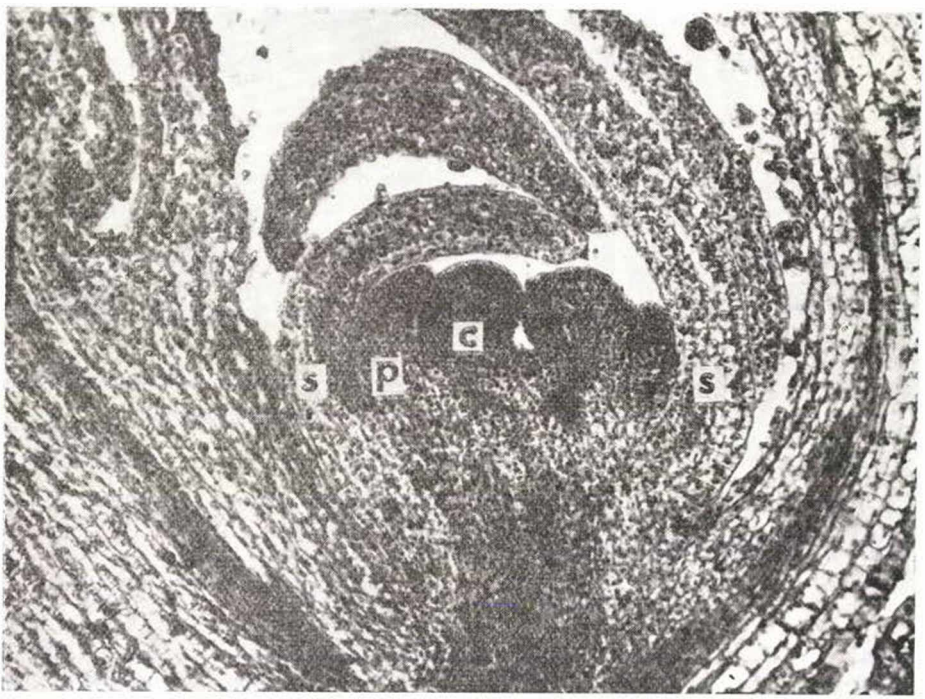

Fig. 3. Floral primordium of *Salvia nemorosa* L. inside the visible young sepals (s) the petal and carpel initials grow with centripetal character and are at the same level. (200x)

region under the pistil (Fig. 4) – the pistil primordium gradually rises during the plication phase and gets into a superior position as compared with the other floral leaves (Fig. 5). Thus, in the case of *Salvia*, the undifferentiated reproductive shoot apex at first flattens and continues to grow rather in width, and so the primordia of the floral leaves (sepal, petal, stamen, pistil) continue to get initiated on its broad and flat surface, at the same level, following one another in a centripetal way.

As compared with that of *Salvia*, the undifferentiated reproductive shoot apex of *Papaver somniferum* L. is also hemispherical; it is typical that the tunica is composed of 4 – 5 cell layers and that the characteristics of the corpus are less meristematic (Sárkány – Percs, 1957). Unlike that of Salvia, the shoot apex remains hemispherical. Differentiation begins at the lateral

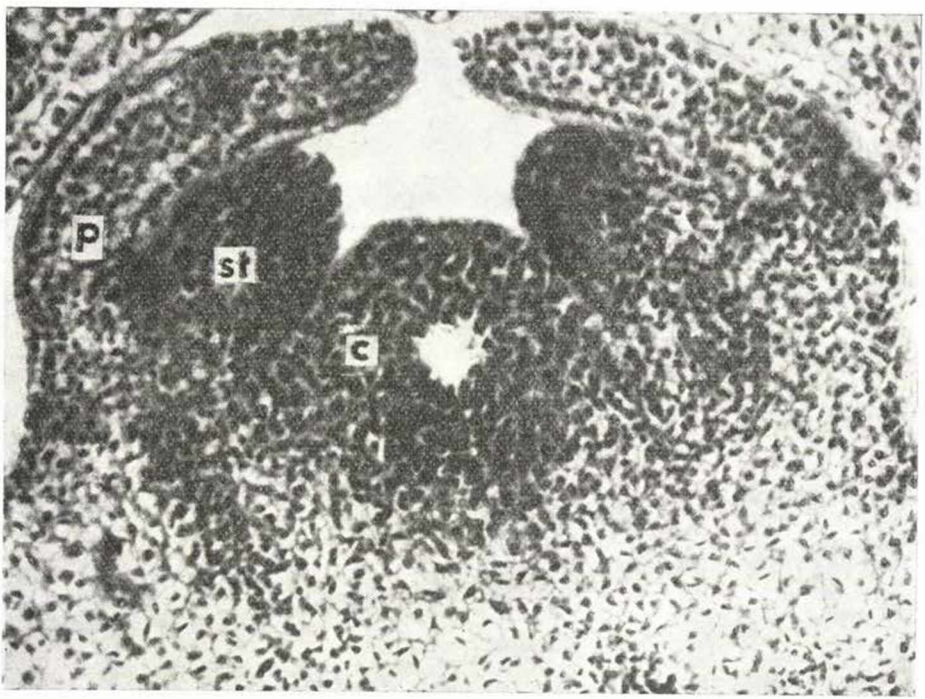

Fig. 4. *Salvia nemorosa* L. a somewhat older stage. Within the stamen initials (st) congenitally interlaced with petal initials (p) there is an active meristematic zone which remains under the level of the carpels (c) interlaced in the plication phase. (400x)

part and in the basal zone of the shoot apex, in the third tunica layer, and so decussate sepal primordia are differentiated (Fig. 6). Due to their growth in length and thickness, the sepal initials soon become as high as the shoot apex, which they subsequently cover while overlapping one another; so a closed protective cover develops around the shoot apex which increases meanwhile not only in lateral sense, but in height as well.

Further cell divisions take place above the sepal primordia, and four petal initials develop along the diagonal plane. It is characteristic that, after protruding from the surface of the shoot apex, their growth slows down and the rate of organization soon shifts over towards the formation of the stamen region and the gynoecium. The petal initials have hardly appeared when further divisions take place at the side of the shoot apex, somewhat higher in the third

Fig. 5. Medium development flower of *Salvia nemorosa* L., the young pistil is in superior position as compared to the level of the other floral leaves. (160x)

tunica layer (Fig. 7). At first the uniform broad ring of the stamen region emerges, from which 180—200 stamen initials develop after a while. The undifferentiated surface of the shoot apex becomes always flatter above the level of the stamen initials, it takes a broad plate-like shape; due to the divisions beginning within the fourth and fifthy tunica layers the peripheral part vaults in an annular form, and a congenitally interlaced, tissue ring of 10—16 carpel initials develops (Figs. 8 and 9).

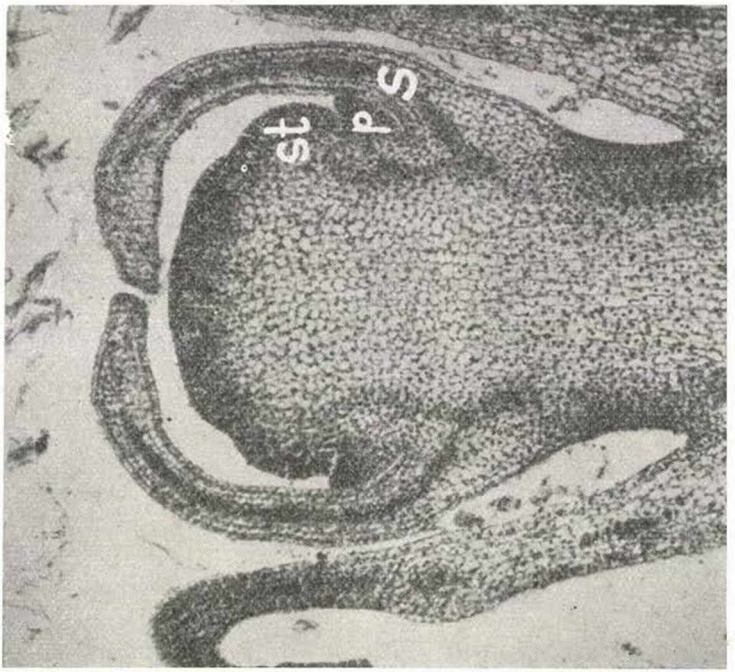

Fig. 7. Centripetal petal initials(p) and a uniform stamen initial (st) develop above the sepal primordia (s) on the reproductive shoot apex of *Papaver somniferum* L. (200x)

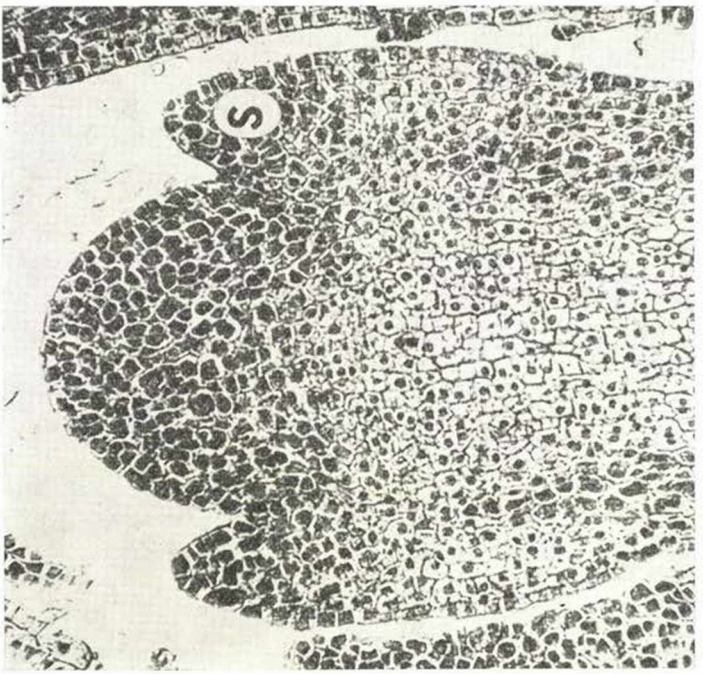

Fig. 6. Reproductive shoot apex of *Papaver somniferum* L. with two sepal initials (s). (400x)

It is characteristic of the floral primordium of *Papaver somniferum* that the primordia of the floral leaves develop from the bottom upwards, in acropetal sequence, at the side of the reproductive shoot apex which remains hemispherical throughout the process of development.

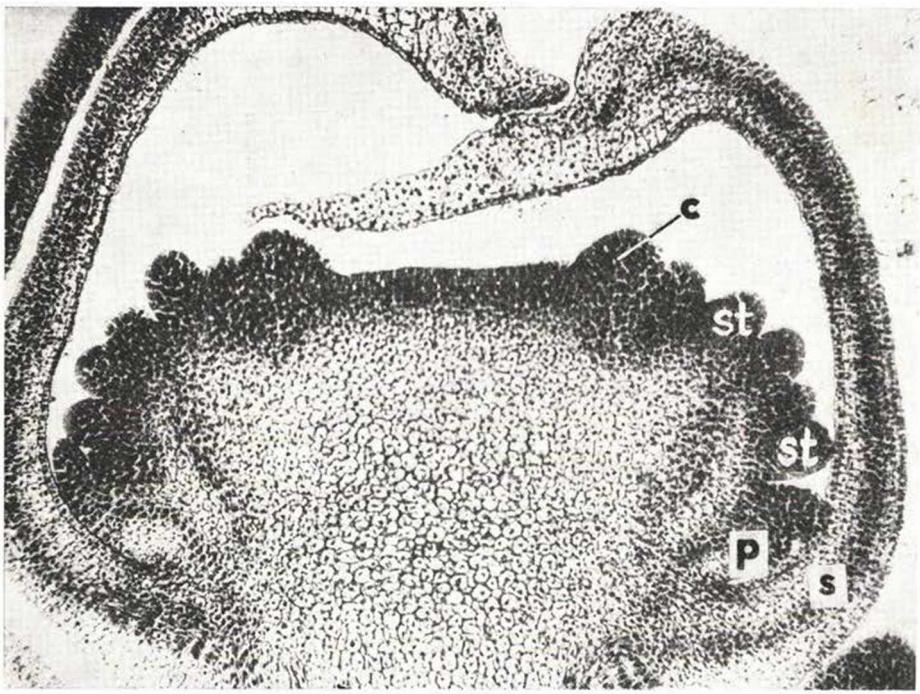

Fig. 8. The uniform initial of carpels (c) appears in the apical zone over the stamen initials differentiated in 4 – 5 rows on the floral primordium of *Papaver somniferum* L. (200x)

As shown by the comparative examination of the floral primordia of these two species with superior pistils, the initials of floral leaves develop on the flattening reproductive shoot apex of *Salvia nemorosa* L. horizontally and centripetally, from outside inwards, and so the carpel initials get at first into an inferior position and only later into a superior one. In the case of *Papaver somniferum* L. the organization of sepal initials begins in the basal zone of the hemispherical reproductive shoot apex; the initials of petals and anthers develop from the bottom upwards, with an acropetal character and the carpel initials get into a typical superior position.

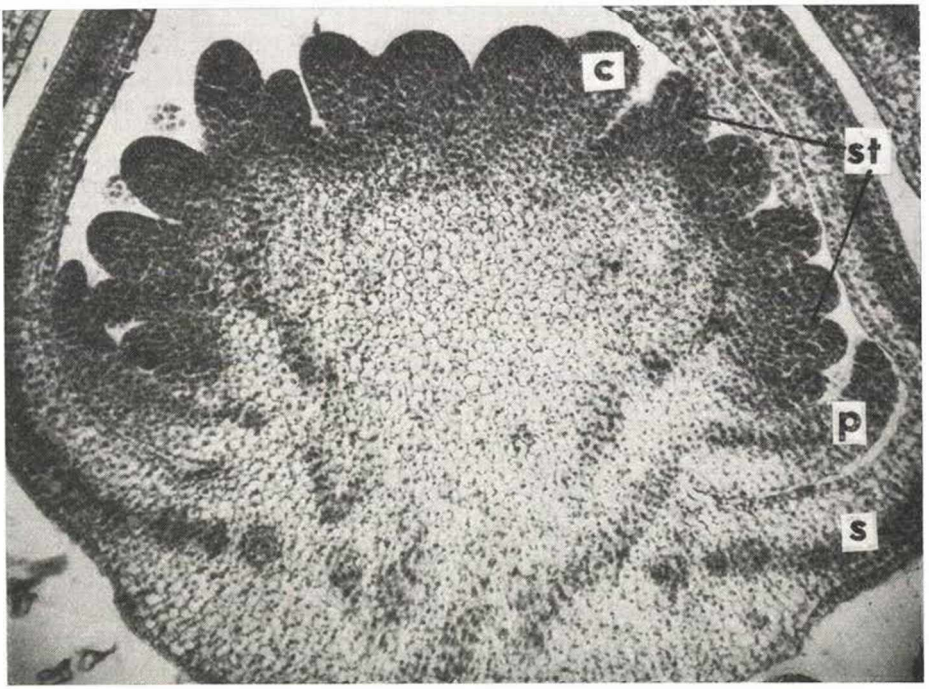

Fig. 9. Veritcal differentiation and centripetal character remain on medium developed floral primordium of *Papaver somniferum* L. s = young sepal, p = petal primordium, st = stamen primordia, c = carpel primordium (200x)

Summary

Shoot apex differenciation and the development of floral primordia of two species with superior pistils – *Salvia nemorosa* L. and *Papaver somniferum* L. – were examined in relation to the position of pistil initials on microtomic serial sections embedded in paraffin.

Hemispherical at the beginning, the undifferentiated floral primordium of *Salvia nemorosa* L. gradually flattens due to the peripheral division at the edge, and the initials of sepals, petals, stamina and carpels are centripetally and horizontally initiated in this order of sequence from the flat surface of the shoot apex, while the volume of the shoot apex increases rather in a lateral sense. During the plication phase the meristematic zone which remains under the carpel initials gradually lifts the developing pistil which thus becomes superior.

On the hemispherical floral shoot apex of *Papaver somniferum* L. the sepal primordia are initiated in the lateral and basal zone while the shoot apex grows not only in width but also in height. Located somewhat higher than the sepal initials, the petal initials are equally formed on the lateral surface of the shoot

apex. The anther initials appear with acropetal character, still on the lateral part of the shoot apex, in 5–6 levels, and only the annular initial of the pistil develops on the flattened upper part of the shoot apex.

In the organization of the two superior pistils the development of poppy may be regarded as typical, while *Salvia nemorosa* L. shows at the beginning of development, particularly in the undifferentiated stage of the shoot apex and when already differentiated into petal, sepal, anther and pistil initials, a close resemblance to the development of inferior pistils; later on, this character disappears and a flower with superior pistil develops.

REFERENCES

Bersillon, G. 1951. Sur le point végétatif de *Papaver somniferum* L. Structure et fonctionant. C. R. Acad. Sci. **232:** 2470–2472.

Bersillon, G. 1955. Sur la formation du bouton floral chez le *Papaver somniferum* L. C. R. Acad. Sci. **240:** 903–905.

Carlson, E. M. and Stuart, B. C. 1936. Development of spores and gametophytes in certain New Wordl species of *Salvia*. New Phytologist **35:** 68–91.

Eames, A. J. – Mac Daniels, L. C. 1947. An introduction to plant anatomy. London–Toronto–New York. Mc Graw-Hill.

Gracza, P. 1964. A *Papaver somniferum* L. virágszerveződésének és magkialakulásának néhány kérdése. Budapest. Doktori disszertáció.

Gracza, P. 1967. The development of the pistil in *Syringa vulgaris* L. Acta Agron. Acad. Sci. Hung. **4.** 439–442.

Sárkány, S. – Percs, E. 1957. Histogenetic observations in the stem tip of Papaver somniferum L. Acta Biol. Acad. Sci. Hung. **7:** 183–210.

Sárkány, S. – Szalai, I. 1966. Növénytani praktikum I. Növényszervezettani gyakorlatok III. kiadás, Budapest. Tankönyvkiadó.

Sbhuman, K. 1904. Praktikum für morphologische und systematische Botanik, Jena. Gustav Fischer.

Soléreder, H. 1908. Systematic anatomy of the dycotyledons. English edition translated by L. A. Boodle and F. E. Fritsch. Oxford. Ferdinand Enke.

Takthajan, A. L. 1948. Die morphologische Evolution der Angiospermen. Moskau. Gustav Fischer.

Van Tieghem, Ph. 1961. Recherches sur la structure du pistil. Paris Imprimerie Nationale.